about once every 14 years with a 2.4-inch (0.06-meter) increase in the tidal departure lasting for 2 to 3 years (Flick, 1998). In addition, the added probability of experiencing more severe winter storms during El Nino periods increases the likelihood of coincident storm waves and increased storm surge elevations. The maximum water level observed in the Santa Barbara Channel was recorded at Rincon Island on the Ventura County coastline when an elevation of +7.8 feet (2.4 meters) above MLLW was measured on January 27, 1983. Local wind and wave setup caused by surf will increase this water level further.

2.3 Wave Climate

Wind waves and swell within the Santa Barbara Channel area are produced by six basic meteorological weather patterns. These include extratropical storm swells in the northern hemisphere (north or northwest swell), wind swells generated by northwest winds in the outer coastal waters (wind swell), westerly (west sea) and southeasterly (southeast sea) local seas, storm swells of tropical storms and hurricanes off the Mexican coast, and southerly swells originating in the southern hemisphere (southerly swell). Because of the partial shelter effects provided by the Channel Islands, the wave climate at the site is dominated by sea and swell from the westerly directions.

Characteristics of the prevailing wave climate may be inferred from the Coastal Data Information Program (CDIP) Goleta Buoy, which was deployed on June 25, 2002, in water depth of approximately 600 feet (183 meters). One-year of wave data measured by this buoy between December 2002 and November 2003 was used as the representative offshore deep-water wave conditions in the present analysis. A summary of this data is reproduced in Figure 3.

The Goleta Buoy data indicates that the measured significant wave height ranged from 1.3 to 11.8 feet (0.4 to 3.6 meters), and period varied from 4 to 23 seconds. Waves approach direction ranged from an azimuth of 100 to 280 degrees. It is found from the statistic analysis that the annual mean significant wave height is 3.5 feet (1.1 meters), mean (peak) wave period is 9.1 seconds and wave approach angle is 259 degrees. The analysis also indicates that for the one-year period of record, approximately 98 percent

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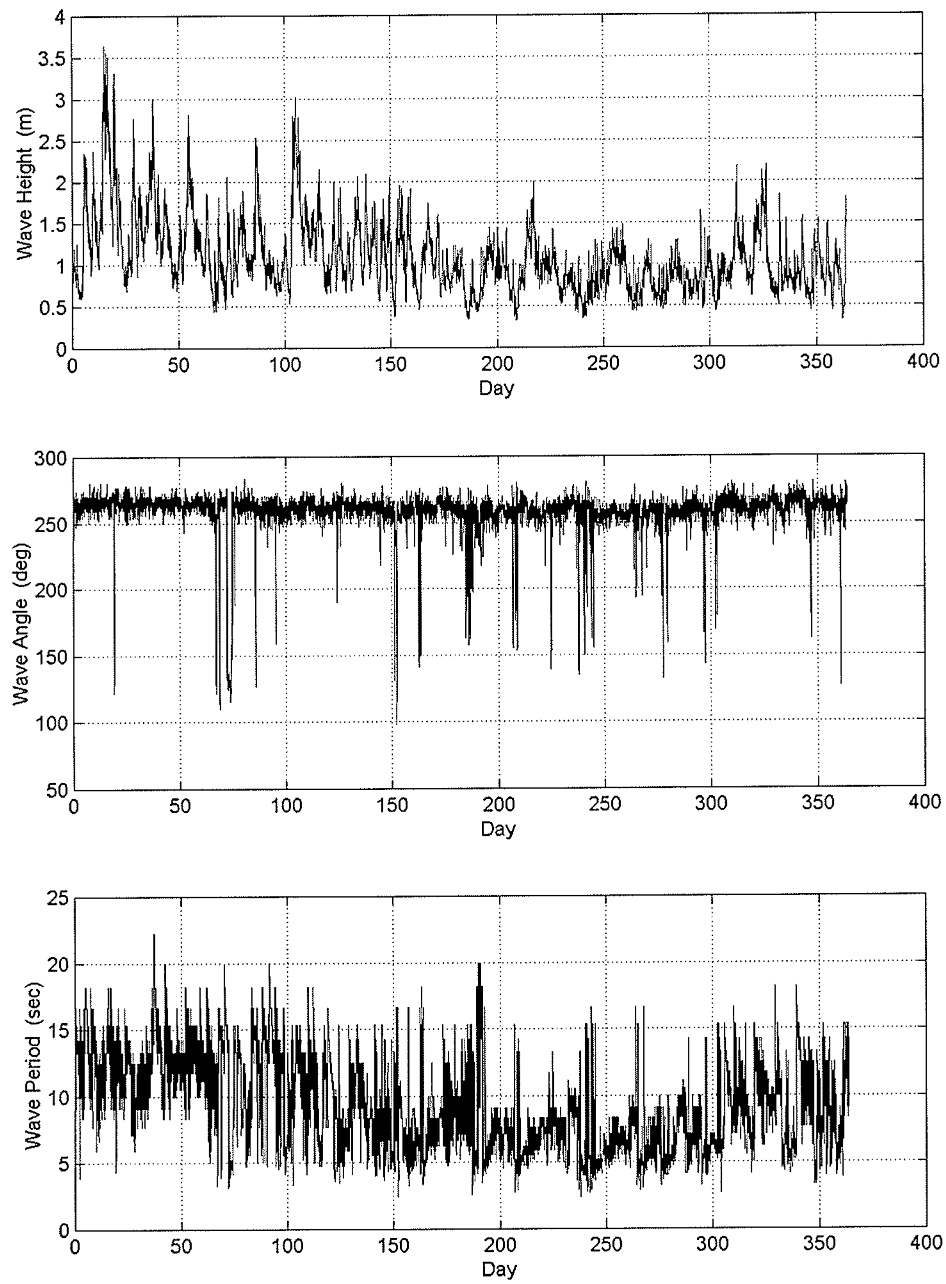

Figure 3. Offshore Wave Conditions Measured by CDIP Goleta Buoy

Source: http://cdip.ucsd.edu/tmp/stream_frame11307.html

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of the deep-water waves propagated onshore with wave approach angles greater than 220 degrees azimuth.

The approximate shoreline orientation near the PRC-421 site is an azimuth of 127 degrees. At this location the azimuth of the landward shore-normal transect is 37 degrees. The predominant wave approach direction from west to east is in agreement with the understanding that the along-shore current and sediment transport direction are almost always from upcoast to downcoast.

Extreme wave events were reviewed by Pacific Weather Analysis for the PRC-421 site (Fairweather Pacific, LLC, 2003). The most severe sixteen storms that occurred between 1931 and 2002 were hindcast and ranked. The analysis indicates that the significant wave heights due to storm swell events at the remnant structure site may be expected to vary from about 10 to 20 feet (3 to 6.1 meters) with periods ranging from 13 to 18 seconds. Based upon this data, a 15-foot (4.6-meter) significant wave height is estimated to have a return probability equivalent to a recurrence interval of once every 10 years. Depending on the magnitude of the incident storm swell and the coincident tide level, the biggest wave sets during the more severe storm swell events will break and partially dissipate over the mound.

2.4 Coastal Processes

Data regarding shoreline processes for the Ellwood shoreline is limited. Along-shore sediment transport at the site is understood to be nearly unidirectional from west to east. The estimated littoral transport rate is approximately 275,000 cubic yards (210,000 cubic meters) per year (Noble Consultants, 1989).

The principal components of the area's sediment budget include sediment delivery from the tributary creeks and streams of the Santa Ynez Mountain watershed and the smaller contributions from bluff erosion between Point Conception and the site. The relatively limited sand supply within the shoreline reach and the characteristics of the local geology and bluff morphology explain why the beaches have evolved into the relatively narrow and sediment limited features that exist today. Over the past 70 years, the beaches have remained relatively stable. Temporal variation in berm width occurs regularly due to seasonal changes and short-term storm events. Seasonal changes have been measured to be about 50 feet (15 meters). Short-term storm erosion and recovery sequences can be greater.

A summary of beach profile data surveyed at Ellwood since 1987 is summarized in Figure 4.

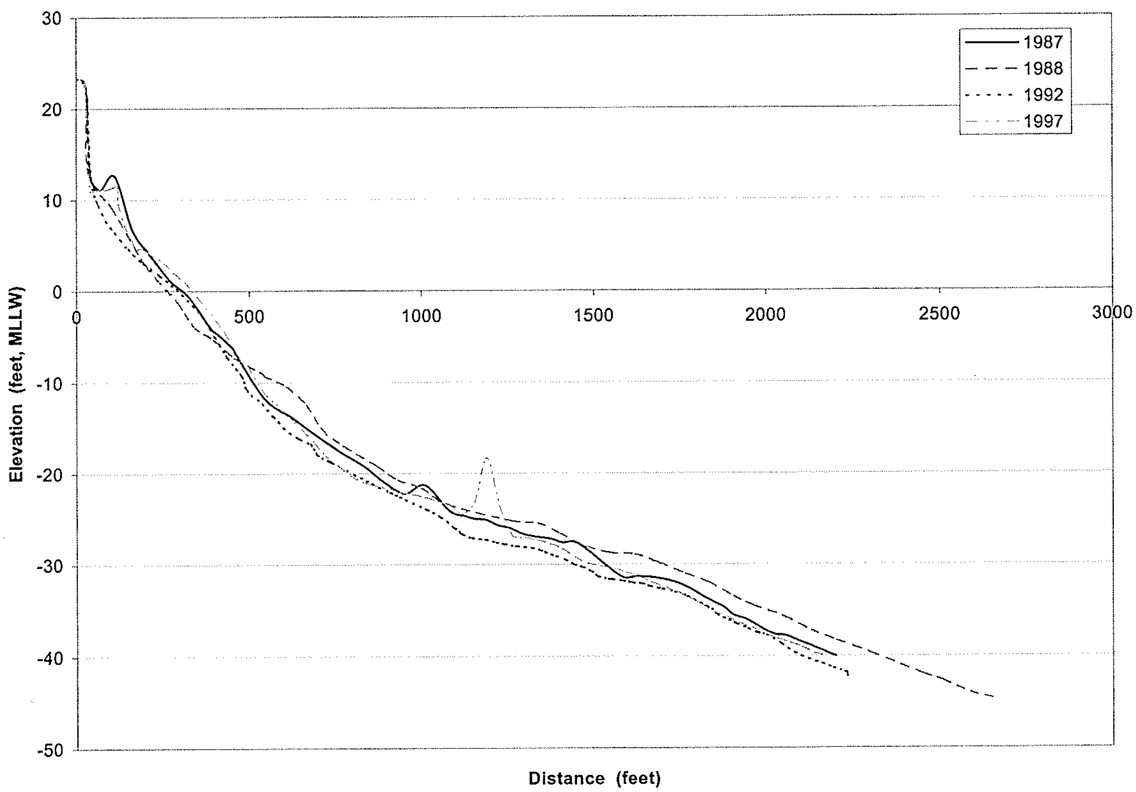

Figure 4. Beach Profiles at Ellwood **Source: Coastal Frontiers, 1987 – 1997**

3. PROJECT ASSESSMENT

3.1 Simulation of Nearshore Processes

Impact assessment of the proposed PRC-421 submerged hardbottom substrate feature was conducted with the aid of numerical model studies performed as part of this study.

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3.1.1 Model Description

The model used in this analysis is a coupled nearshore wave-current-sediment transport model system (Qin, 2003), which is capable of simulating nearshore wave propagation, wave-induced along-shore and cross-shore currents, along-shore and cross-shore sediment transport as well as beach evolution. Several wave models and sediment transport models can be selected in this model system. In this analysis, the REF/DIF1 (Kirby and Dalrymple, 1994) was used as the wave module to simulate wave transformation including shoaling, refraction, diffraction and breaking and to provide drive forcing such as the radiation stress and wave volume flux for the quasi-3D nearshore circulation module of SHORECIRC (Svendsen et. al, 2002). The Bailard (1981) formula, as improved by Qin (2003), was used to calculate the along-shore and cross-shore sediment transport potential using the hydrodynamic characteristics estimated by the wave and circulation modules.

3.1.2 Model Setup

<u>Bathymetry and Modeled Area</u>

Hydrographic survey data from the National Ocean Service was used to construct the nearshore bathymetry for the without project scenario. The proposed hardbottom substrate feature was simulated as a flat cylinder shape 170 feet in diameter (52 meters) and 9 feet (2.7 meters) above the existing seabed. The original depth data is shown in Figure 5, and the bathymetries for the without and with project conditions are shown in Figure 6.

The modeled area in this analysis covers 330 feet (100 meters) upcoast and 660 feet (200 meters) downcoast of the structure site in the alongshore direction, and 660 feet (200 meters) seaward and 1,180 feet (360 meters) shoreward of the structure in the cross-shore direction, as shown in Figure 6. The spatial interval used in the model is 16 feet (5 meters).

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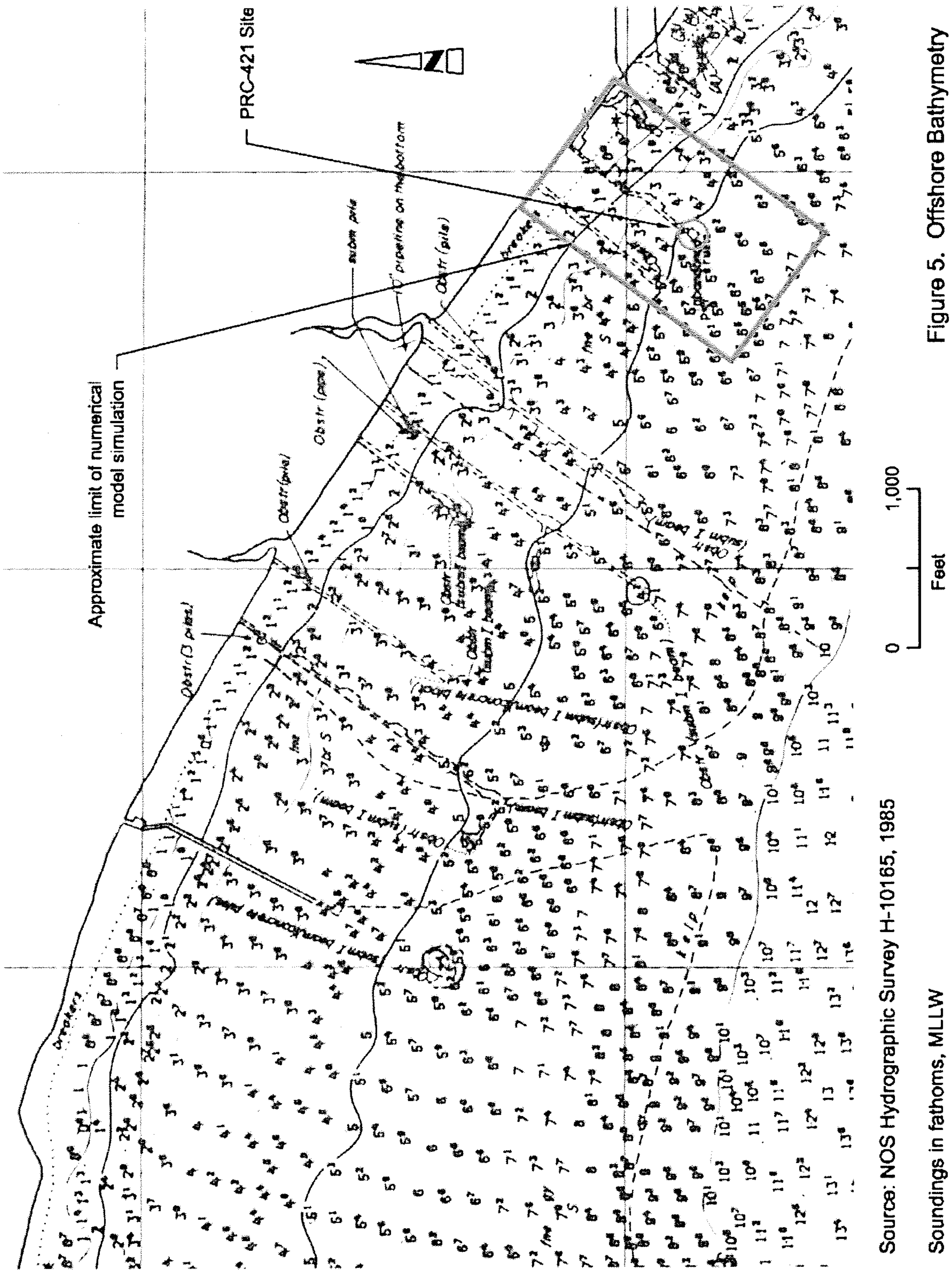

Figure 5. Offshore Bathymetry

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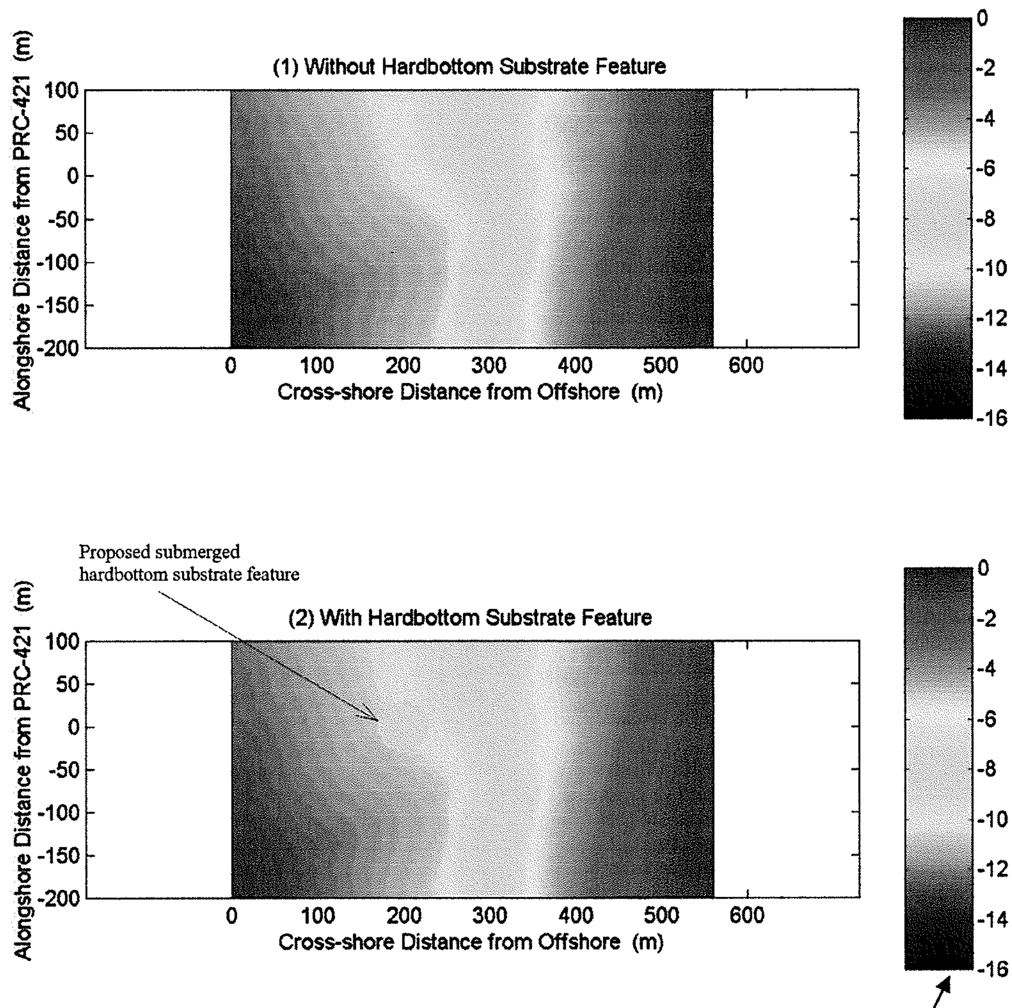

Note: Colors refer to elevation in meters below MLLW datum as defined on graduated scale

Figure 6. Nearshore Bottom Elevation (Meter, MLLW)
without and with the Hardbottom Substrate Feature

<u>Offshore Boundary Conditions</u>

The offshore boundary conditions required by the model include the wave height, wave angle and wave direction along the offshore boundary of the modeled area, which is approximately 46 feet (14 meters) deep. The boundary wave conditions of the model simulation were estimated by transforming the offshore deep-water waves measured by

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the CDIP Goleta Buoy to the water depth of 46 feet (14 meters) using the shoaling-refraction relation. Simulation Procedures

In order to assess the long-term averaged impacts of the structure on the coastal processes, the available one-year record of CDIP Goleta Buoy data was used to simulate conditions at the site for the without and with project scenarios. The deep-water wave data were first sorted and grouped into categories of joint wave height and direction of approach events. The frequency of occurrence of each wave angle and wave height band was then computed. The nearshore wave transformation, wave-induced circulation and sediment transport potential were estimated for each category using the coupled wave-current-sediment transport model. Finally, an annually averaged estimate of wave transformation, circulation and sediment transport potential was computed by summing results and multiplying subtotals by the respective occurrence frequencies.

3.1.3 Modeled Scenarios

Simulations were confined to a simplified representation of the without and with project condition to accommodate the constraints of the numerical model capabilities. The existing conditions scenario did not include the geometry of the existing PRC-421 remnant structures, and the with project condition model analysis did not include the proposed bird roost platform support piles. Analysis was confined to a numerical simulation of the much larger and dominant submerged mound feature.

The effects of the existing remnant caissons and the small diameter piles proposed to support the bird roosting platforms on the local wave climate is considered to be insignificant. Their number and profile is relatively small in comparison to the larger diameter submerged mound. Furthermore, hydraulic model studies summarized in Wiegel (1964) indicate that a small number of widely spaced piles will not significantly alter wave conditions.

Based upon this information, it is estimated that the remnant caissons would only attenuate wave heights by about three percent or less within a very small area. Therefore comparison of an existing condition having no structures to the case of the

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